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NOTIFICATION OF ELECTION

(PCT Rule 61.2)

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in its capacity as elected Office

Date of mailing (day/month/year) 23 May 2000 (23.05.00)	
International application No. PCT/FI99/00840	**Applicant's or agent's file reference** 2980538PC/nu
International filing date (day/month/year) 11 October 1999 (11.10.99)	**Priority date** (day/month/year) 13 October 1998 (13.10.98)
Applicant KANGAS, Arto et al	

1. The designated Office is hereby notified of its election made:

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26 April 2000 (26.04.00)

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PCT REQUEST

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0 0-1	For receiving Office use only International Application No.	PCT/FI99/00840
0-2	International Filing Date	11 OCT 1999 (11.10.99)
0-3	Name of receiving Office and "PCT International Application"	The Finnish Patent Office PCT International Application
0-4 0-4-1	Form - PCT/RO/101 PCT Request Prepared using	PCT-EASY Version 2.84 (updated 01.07.1999)
0-5	Petition The undersigned requests that the present international application be processed according to the Patent Cooperation Treaty	
0-6	Receiving Office (specified by the applicant)	National Board of Patents and Registration (Finland) (RO/FI)
0-7	Applicant's or agent's file reference	2980538PC/nu
I	Title of invention	DATA TRANSMISSION RESOURCES OPTIMIZATION
II II-1 II-2 II-4 II-5 II-6 II-7	Applicant This person is: Applicant for Name Address: State of nationality State of residence	 applicant only all designated States except US NOKIA NETWORKS OY Keilalahdentie 4 FIN-02150 Espoo Finland FI FI
III-1 III-1-1 III-1-2 III-1-4 III-1-5 III-1-6 III-1-7	Applicant and/or inventor This person is: Applicant for Name (LAST, First) Address: State of nationality State of residence	 applicant and inventor US only KANGAS, Arto Keulakuja 4 D 13 FIN-02320 Espoo Finland FI FI

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III-2	**Applicant and/or inventor**	
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IV-1	**Agent or common representative; or address for correspondence** The person identified below is hereby/has been appointed to act on behalf of the applicant(s) before the competent International Authorities as:	agent
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V	**Designation of States**	
V-1	Regional Patent (other kinds of protection or treatment, if any, are specified between parentheses after the designation(s) concerned)	AP: GH GM KE LS MW SD SL SZ UG ZW and any other State which is a Contracting State of the Harare Protocol and of the PCT EA: AM AZ BY KG KZ MD RU TJ TM and any other State which is a Contracting State of the Eurasian Patent Convention and of the PCT EP: AT BE CH&LI CY DE DK ES FI FR GB GR IE IT LU MC NL PT SE and any other State which is a Contracting State of the European Patent Convention and of the PCT OA: BF BJ CF CG CI CM GA GN GW ML MR NE SN TD TG and any other State which is a member State of OAPI and a Contracting State of the PCT

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V-2	National Patent (other kinds of protection or treatment, if any, are specified between parentheses after the designation(s) concerned)	AE AL AM AT (patent and utility model) AU AZ BA BB BG BR BY CA CH&LI CN CR CU CZ (patent and utility model) DE (patent and utility model) DK (patent and utility model) DM EE (patent and utility model) ES FI (patent and utility model) GB GD GE GH GM HR HU ID IL IN IS JP KE KG KP KR KZ LC LK LR LS LT LU LV MD MG MK MN MW MX NO NZ PL PT RO RU SD SE SG SI SK (patent and utility model) SL TJ TM TR TT TZ UA UG US UZ VN YU ZA ZW	
V-3	National Patent (States which have become party to the PCT after the issuance of this version of EASY)	MA Morocco	
V-5	**Precautionary Designation Statement** In addition to the designations made under items V-1, V-2 and V-3, the applicant also makes under Rule 4.9(b) all designations which would be permitted under the PCT except any designation(s) of the State(s) indicated under item V-6 below. The applicant declares that those additional designations are subject to confirmation and that any designation which is not confirmed before the expiration of 15 months from the priority date is to be regarded as withdrawn by the applicant at the expiration of that time limit.		
V-6	**Exclusion(s) from precautionary designations**	NONE	
VI-1	**Priority claim of earlier national application**		
VI-1-1	Filing date	13 October 1998 (13.10.1998)	
VI-1-2	Number	982222	
VI-1-3	Country	FI	
VI-2	**Priority document request** The receiving Office is requested to prepare and transmit to the International Bureau a certified copy of the earlier application(s) identified above as item(s):	VI-1	
VII-1	**International Searching Authority Chosen**	Swedish Patent Office (ISA/SE)	
VIII	**Check list**	number of sheets	electronic file(s) attached
VIII-1	Request	4	-
VIII-2	Description	18	-
VIII-3	Claims	5	-
VIII-4	Abstract	1	2980538p.txt
VIII-5	Drawings	4	-
VIII-7	TOTAL	32	
	Accompanying items	paper document(s) attached	electronic file(s) attached
VIII-8	Fee calculation sheet	✓	-
VIII-16	PCT-EASY diskette	-	diskette
VIII-17	Other (specified):	Copy of Official Action	-

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VIII-18	Figure of the drawings which should accompany the abstract	2
VIII-19	Language of filing of the international application	English
IX-1	Signature of applicant or agent	Leo Lehtonen
IX-1-1	Name	KOLSTER OY AB

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10-1	Date of actual receipt of the purported international application	11 OCT 1999 (1999)
10-2	Drawings:	
10-2-1	Received	
10-2-2	Not received	
10-3	Corrected date of actual receipt due to later but timely received papers or drawings completing the purported international application	
10-4	Date of timely receipt of the required corrections under PCT Article 11(2)	
10-5	International Searching Authority	ISA/SE
10-6	Transmittal of search copy delayed until search fee is paid	

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11-1	Date of receipt of the record copy by the International Bureau	

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 99/00840

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: H04Q 7/24
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: H04Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 9723110 A1 (NOKIA TELECOMMUNICATIONS OY), 26 June 1997 (26.06.97), page 3, line 6 - page 5, line 12 --	1,11,15,19
A	WO 9610320 A2 (NOKIA TELECOMMUNICATIONS OY), 4 April 1996 (04.04.96), abstract --	1,11,15,19

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

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"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
17 March 2000	22 -03- 2000
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Jaana Raivio/cs Telephone No. +46 8 782 25 00

INTERNATIONAL SEARCH REPORT

Information on patent family members

02/12/99

International application No.
PCT/FI 99/00840

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9723110 A1	26/06/97	AU 1099397 A	14/07/97
		EP 0868826 A	07/10/98
		FI 101924 B	00/00/00
		FI 956089 A	19/06/97
WO 9610320 A2	04/04/96	AU 701594 B	04/02/99
		AU 3523995 A	19/04/96
		CA 2200308 A	04/04/96
		EP 0783826 A	16/07/97
		FI 96557 B,C	29/03/96
		FI 944487 D	00/00/00
		FI 971269 A	26/03/97
		JP 10511818 T	10/11/98

APPLICATION UNDER UNITED STATES PATENT LAWS

Atty. Dkt. No. PW 280086/2980538US/HS/kop
(M#)

Invention: DATA TRANSMISSION RESOURCES OPTIMIZATION

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This is a:

- ☐ Provisional Application
- ☐ Regular Utility Application
- ☐ Continuing Application
  - ☒ The contents of the parent are incorporated by reference
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- ☐ Design Application
- ☐ Reissue Application
- ☐ Plant Application
- ☐ Substitute Specification
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SPECIFICATION

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WORLD INTELLECTUAL PROPERTY ORGANIZATION
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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 7 :
H04Q 7/24

A1

(11) International Publication Number: WO 00/22854

(43) International Publication Date: 20 April 2000 (20.04.00)

(21) International Application Number: PCT/FI99/00840

(22) International Filing Date: 11 October 1999 (11.10.99)

(30) Priority Data:
982222 13 October 1998 (13.10.98) FI

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(81) Designated States: AE, AL, AM, AT, AT (Utility model), AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CR, CU, CZ, CZ (Utility model), DE, DE (Utility model), DK, DK (Utility model), DM, EE, EE (Utility model), ES, FI, FI (Utility model), GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SK (Utility model), SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

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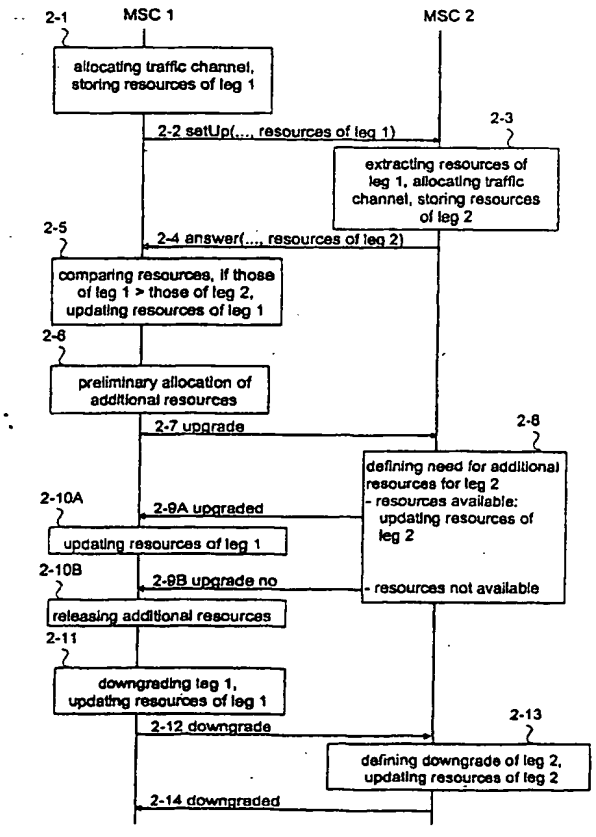
Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.

(54) Title: DATA TRANSMISSION RESOURCES OPTIMIZATION

(57) Abstract

A method and an apparatus implementing the method for optimizing data transmission resources, particularly resources on the air interface, between terminals and a network element. In order to decrease differences in the capacities of different legs or connection parts in the connection, the network adapts (2–5, 2–10A, 2–13) the traffic channel resources between the terminal and the network to the outward connection of the network element, e.g. the connection to another mobile station or a fixed network, by observing and comparing the data transmission capacity of the connection parts or by receiving the information (2–4, 2–9A, 2–9B, 2–12, 2–14) from the outward connection part on its data transmission capacity.



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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 7 : H04Q 7/24 — A1

(11) International Publication Number: **WO 00/22854**

(43) International Publication Date: 20 April 2000 (20.04.00)

(21) International Application Number: PCT/FI99/00840

(22) International Filing Date: 11 October 1999 (11.10.99)

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(71) Applicant *(for all designated States except US)*: NOKIA NETWORKS OY [FI/FI]; Keilalahdentie 4, FIN–02150 Espoo (FI).

(72) Inventors; and

(75) Inventors/Applicants *(for US only)*: KANGAS, Arto [FI/FI]; Keulakuja 4 D 13, FIN–02320 Espoo (FI). JUPPI, Anssi [FI/FI]; Markkinatie 6 A 6, FIN–00700 Helsinki (FI). RÄSÄNEN, Juha [FI/FI]; Pensaskertuntie 8 A, FIN–02660 Espoo (FI).

(74) Agent: KOLSTER OY AB; Iso Roobertinkatu 23, P.O. Box 148, FIN–00121 Helsinki (FI).

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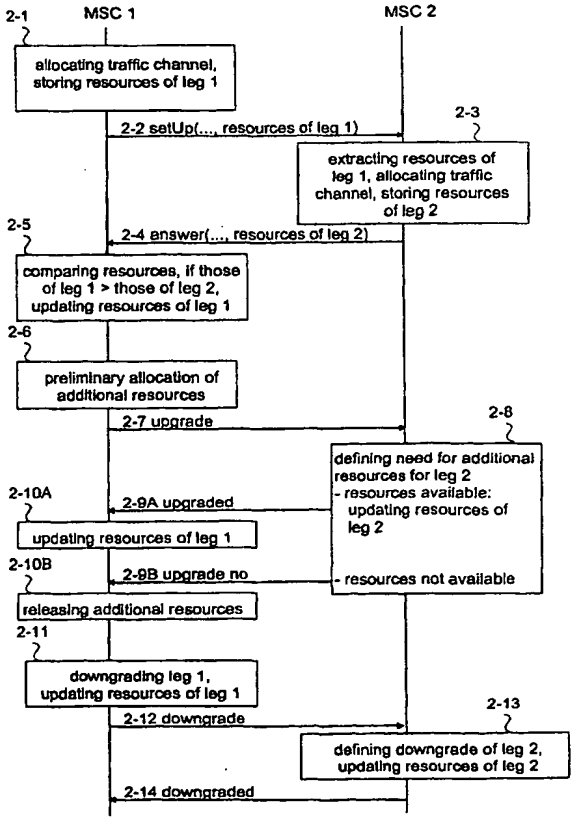

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DATA TRANSMISSION RESOURCES OPTIMIZATION

BACKGROUND OF THE INVENTION

The invention relates to the optimization of the use of data transmission resources in a data call, and particularly to the optimization of the use of traffic channels on the air interface of high speed data transmission services based on multichannel technology.

Modern mobile communication systems provide subscribers with both normal speech transmission and various data transmission functions. In mobile communication systems, the available data transmission capacity on the air interface is divided between several users by a multiple access principle. The most common multiple access principles include time division multiple access (TDMA), code division multiple access (CDMA) and frequency division multiple access (FDMA). In TDMA systems, communication over a radio path takes place on a time division basis in successive recurrent TDMA frames, each of which comprises several time slots. Time slots are mainly used for transferring control channels and traffic channels. Traffic channels are used for transmitting speech and data. In this application, data refers to any information conveyed in a digital telecommunication system. Such information may comprise digitized speech, inter-computer data communication, telefax data, short program code segments etc. Control channels are used for signalling between a base transceiver station and mobile stations. An example of a TDMA radio system is the pan-European mobile system GSM (Global System for Mobile Communications).

Depending on the data transmission rate required, a traffic channel may comprise one subchannel (e.g. a TDMA time slot) or many subchannels (e.g. many TDMA time slots for a high speed data transmission) in modern mobile communication systems. For example in the GSM system, a high speed data service HSCSD (High Speed Circuit Switch Data) is defined, in which data service a traffic channel may comprise several subchannels. Channels and subchannels can be allocated symmetrically or asymmetrically. Correspondingly, a high speed data service has been planned for e.g. the third-generation mobile communication systems, such as the UMTS (Universal Mobile Telecommunication System) and the IMT-2000 (International Mobile Telecommunication 2000). Also in professional mobile radio systems, e.g. the TETRA (Terrestrial Trunked Radio), it is possible to allocate several subchan-

nels to one connection. The user data transmission rate on the air interface is affected by the number of subchannels and also the used channel coding method.

Figure 1 shows one possible data transmission situation in the GSM system. In the example of Figure 1, a data transmission call is a call between two mobile stations. When a mobile station MS A makes a data transmission call to a mobile station MS B, a leg 1 is formed for the call, i.e. the connection, between the mobile station MS A and a serving mobile services switching centre MSC 1. Correspondingly, a leg 2 is formed for the same connection between the mobile station MS B and a serving mobile services switching centre MSC 2. For both legs 1 and 2, the number of subchannels required by the data transmission rate is allocated. One leg is not aware of the situation of the other leg, although both legs were served by the same mobile services switching centre. When e.g. the data transmission rate of the call leg 1 on the air interface Air varies e.g. due to the upgrade, i.e. the increase in the number of subchannels, or the downgrade, i.e. the decrease in the number of subchannels, the leg 2 does not follow. As a result of upgrading the leg 1, the mobile station MS A may thus uselessly allocate subchannels from the air interface, which subchannels it is unable to use because of the poorer data transmission rate of the leg 2. Correspondingly, as a result of downgrading the leg 1, the mobile station MS B may allocate subchannels from the air interface uselessly, which subchannels it is unable to use due to the decreased data transmission rate of the leg 1. The situation remains the same, whether the mobile stations MS A and MS B are served by the same or a different mobile services switching centre.

A problem in the arrangement described above is that the air interface cannot be utilized in the most efficient way, because the information on the data transmission rate change of one leg is not conveyed to the other leg of the same connection. The efficient utilization of the radio spectrum is the main factor in planning and implementing mobile communication networks.

The inefficient use of traffic channels may present a problem in a call between a mobile station and a fixed network as well. A fixed network part can offer (e.g. due to an autobauding handshaking of modems or the used fixed network protocol) a data rate much higher or much lower than requested in the call set-up. A problem may also be provisory, caused by the quality of the connection or the network.

In fixed network calls, too, the inefficient use of traffic channels may present a problem. For example, when transferring data in a broadband network between two narrowband ISDN networks, several time slots can be allocated to the connection in the network side, when the data transmission rate in different ISDN network sides is not necessarily the same and the resources on the other side can be wasted.

BRIEF DESCRIPTION OF THE INVENTION

It is thus an object of the invention to provide a method and an apparatus implementing the method to eliminate the above problems. The object of the invention is particularly to utilize the available channel capacity as efficiently as possible. The objects of the invention are achieved by a method, a system and an interworking unit which are characterized by what is said in the independent claims. The preferred embodiments of the invention are disclosed in the dependent claims. An interworking unit refers herein to any network element with an interworking function in a data transmission network.

The invention is based on the network adapting the traffic channel resources between the mobile station and the network to the outward connection of the network element, e.g. the connection to another mobile station or to the fixed network, by observing and comparing the data transmission capacity of connection parts or by receiving information from the outward connection on its data transmission capacity.

The method, system and interworking unit of the invention provide the advantage of using traffic channels, e.g. radio channels, efficiently in multichannel calls. In respect of the capacity of the whole end-to-end connection, there is always an adequate amount of channels allocated. The method provides a user with the highest possible data rate with the lowest possible costs. For the network operator, the method offers network resources measuring and optimization and a service with a better price-quality ratio for users.

In a preferred embodiment of the invention, the capacity allocated from the data transmission resources is controlled by the amount of padding transmitted over the connection and by flow control. This provides the advantage that the information on the capacity of one end need not be separately transmitted, because it can be concluded on the basis of the amount of padding and the flow control. Further, the real need for the capacity will be found out and the capacity will be adapted to it.

In another preferred embodiment of the invention, the capacity allocated from the data transmission resources is controlled by the amount of padding transmitted over the connection and the need for buffering. Also this provides the advantage that the information on the capacity of one end need not be separately transmitted, because it can be concluded on the basis of the amount of padding and the need for buffering. Further, the real need for the capacity will be found out and the capacity will be adapted to it.

In a preferred embodiment of the invention, in which the connection is a connection between mobile stations, the air interface capacities are arranged to correspond to each other by conveying information on the capacity allocated from the air interface to the other mobile station. This provides the advantage that the capacity for the same data transmission rate is allocated to both mobile stations participating in the same call from the air interface.

BRIEF DESCRIPTION OF THE FIGURES

In the following the invention will be described in greater detail in connection with the preferred embodiments, with reference to the attached drawings, in which

Figure 1 illustrates different legs of the same connection,

Figure 2 shows a signalling diagram in the first preferred embodiment of the invention, and

Figures 3 and 4 show the operation according to the second preferred embodiment of the invention as a flow chart.

DETAILED DESCRIPTION OF THE INVENTION

The present invention can be applied both to telecommunication systems based on a fixed network and to all digital wireless telecommunication systems, such as cellular systems, WLL-type (Wireless Local Loop) and RLL-type (Radio Local Loop) networks and satellite-based mobile communication systems. The invention is particularly applicable to optimize the use of the resources on the air interface in a mobile communication system, as the resources on the air interface are limited. In this connection, the term 'mobile communication system' (or network) refers generally to all wireless telecommunication systems. There are several multiple access modulation techniques to facilitate the communication with a plurality of mobile users. These techniques include time division multiple access (TDMA), code division multiple access (CDMA) and frequency division multiple access (FDMA). The physical

concept of a traffic channel varies in different multiple access methods, and it is primarily defined by means of a time slot in TDMA systems, a spreading code in CDMA systems, a radio channel in FDMA systems, a combination of these etc. In modern mobile communication systems, it is possible to allocate a set of two or more basic-rate traffic channels (subchannels), or a so-called high speed traffic channel, to a mobile station for high speed data transmission. In this connection, the term 'traffic channel' refers both to a single basic-rate traffic channel and to a high speed traffic channel consisting of two or more basic-rate traffic channels (subchannels). The basic idea of the present invention is independent of the type of the traffic channel and the multiple access method used.

In the following the invention will be described by using the GSM system as an example without restricting the invention to this system in any way. The structure and operation of the GSM system are known to a person skilled in the art. The basic structure of the GSM system comprises a base station subsystem BSS and a network subsystem NSS. The BSS and the mobile stations MS communicate over radio connections via the air interface Air. In the base station system BSS each cell is served by a base transceiver station BTS. A number of base transceiver stations are connected to a base station controller BSC, which controls the radio frequencies and channels the BTS uses. The BSCs are connected to a mobile services switching centre MSC. Certain mobile services switching centres are connected to other telecommunication networks ON, such as the public switched telephone network PSTN or a data network, and they comprise gateway functions for calls originating from and terminating at those networks. These centres MSC are known as gateway MSCs (GMSC). Further, there are at least two databases, a home location register HLR and a visitor location register VLR.

The mobile communication system comprises adaptation functions to adapt the internal data connection of the mobile communication network to the protocols used by terminals and other telecommunication networks. Typical adaptation functions include a terminal adaptation function TAF (not shown in Figure 1) on the interface between a mobile station and a data terminal connected to the mobile station, and an interworking function IWF on the interface between a mobile communication network and another telecommunication network, usually in connection with a mobile services switching centre. In the example of Figure 1, an interworking unit IWU including the interworking

function IWF is located in the mobile services switching centres MSC 1 and MSC 2. Alternatively, an IWU can be located in some other network element or as an independent element. In this application, the term 'interworking unit' refers thus to a network element comprising an interworking function.

Usually a mobile services switching centre comprises various types of adapter equipment pools for supporting different data services and data protocols, e.g. a modem pool with modems and telefax adapters for modem and telefax services, an UDI/RDI rate adapter pool etc.

In the GSM system, a data connection is established between the terminal adaptation function TAF of the mobile station MS and the interworking function IWF in the mobile communication network. Said GSM data connection is established over the physical connection using one or more traffic channels on the air interface. The IWF switches the GSM data connection to another network, such as the ISDN or another GSM network, or to the public switched telephone network PSTN. If one party of the data connection is a terminal in a fixed network, e.g. the PSTN, the leg 2 is formed between the interworking function of the gateway mobile services switching centre and the terminal. The interworking functions, e.g. the IWF, take care of bearer services, by which e.g. technical prerequisites for switching functions are created for teleservices. A bearer service can guarantee a specific, even as high as 64 kbit/s, user rate on the air interface. The interworking function IWF buffers data packets and performs the flow control. How the flow control and the buffering is performed has no relevance to the present invention, and thus it is not described in greater detail herein.

Data traffic between the MSC/IWU and the base transceiver station is transparent, and the present invention does not affect the operation of other network elements, such as base station controllers BSC or base transceiver stations BTS.

In addition to prior art means needed for data transmission services, the mobile communication system implementing the functionality of the present invention comprises means for adapting the traffic channel capacity on the air interface to correspond to the traffic channel capacity on the air interface of another mobile station in the same data transmission connection, or to the channel capacity of the fixed network used by the connection. The means are preferably located in connection with the call control of the mobile services

switching centre or in connection with the interworking unit. The means or part of the means can also be located somewhere else.

The network structure requires no equipment changes. It comprises processors and memory, which can be utilized in the functions according to the invention. All changes needed for implementing the invention can be performed as added or updated software routines to accomplish the functionality of the invention. Depending on the embodiment of the invention, memory extension may be needed. It is, however, restricted to a small amount which is enough to store excess resource allocation information, i.e. the information on the capacity of each leg.

The term 'capacity' refers herein to a traffic channel on the air interface allocated to a leg and channel coding used therein, which determine the user data transmission rate on the air interface.

In the following, the invention will be described according to the preferred embodiments. How traffic channels and their subchannels and the used channel codings are allocated and how the allocations are changed during the connection, have no relevance to the invention, and thus they are not described in greater detail. It is equally irrelevant to the invention, how the order of data is maintained in multichannel transmission, and so it will not be described in greater detail either.

Figure 2 illustrates signalling according to the first preferred embodiment of the invention. In the first preferred embodiment of the invention, leg-specific channel allocation information of the connection is maintained in the mobile services switching centre. In the example of Figure 2, two mobile stations under different switching centres participate in the call. If mobile stations are under the same switching centre, the signalling in Figure 2 represents internal signalling of the switching centre. In other words, the mobile services switching centre MSC 1 shows a call process taking care of the leg 1 and the MSC 2 shows a call process taking care of the leg 2. Their physical location may change during the connection because of the handover between switching centres performed by the mobile station. It is further assumed that in the used channel allocation method a slower connection is established, if the amount of resources required by the desired data transmission rate is not available.

At step 2-1, the mobile services switching centre MSC 1 has received a call set-up request to the mobile station B from the mobile station A.

The call set-up request includes the data transmission rate requested for the connection, on the basis of which data transmission rate the mobile services switching centre MSC 1 allocates the traffic channel to the connection and forms a leg 1. At the same time, the mobile services switching centre stores the information on the connection and the resources allocated on the air interface to the leg 1 of the connection. The information on the resources allocated to the connection is indicated for example in the form of the amount of the allocated subchannels and the used channel coding and/or the user data transmission rate on the air interface.

Then the mobile services switching centre MSC 1 routes the call set-up request to the mobile services switching centre MSC 2 serving the mobile station B and transmits the call set-up request (setUp) in the message 2-2. In the first preferred embodiment of the invention, both the normal parameters and the information on the resources allocated to the leg 1 on the air interfaces are added to the call set-up request.

Thereafter, the mobile services switching centre MSC 2 extracts also the information on the resources allocated to the leg 1 from the call set-up request. The mobile services switching centre MSC 2 allocates the traffic channel to the leg 2 of the connection preferably to correspond to the resources allocated to the leg 1 at step 2-3. If the mobile services switching centre MSC 2 has not enough subchannels available, less resources are allocated to the leg 2 than it has been allocated to the leg 1. In the first preferred embodiment of the invention, however, no more resources are allocated to the leg 2 than to the leg 1. As the traffic channel has been allocated, the mobile services switching centre MSC 2 stores the information on the resources allocated to the leg 2 at step 2-3. Then the mobile services switching centre MSC 2 transmits an answer message (2-4) to the call set-up request. In the first preferred embodiment, the answer includes the information on the resources allocated to the leg 2. In some other embodiments, the message 2-4 includes the information on the resources allocated to the leg 2 only when it could not be allocated as much resources to the leg 2 as to the leg 1.

Upon receiving the message 2-4, the mobile services switching centre MSC 1 extracts the information on the resources allocated to the leg 2 from the message at step 2-5 and compares them with the resources allocated to the leg 1. If the resources allocated to the leg 2 are smaller than the resources allocated to the leg 1, the mobile services switching centre MSC 1

preferably releases part of the resources allocated to the leg 1 in such a manner that the resources of both legs correspond to each other, and updates the information on the resources allocated to the leg 1 to correspond to the changed situation. This provides the advantage that the resources on the air interface of both sides are able to convey data with the same transmission rate in such a manner that the need for the flow control and the buffering is minimized and that the resources are not uselessly allocated on either of the air interfaces.

When the resources on the air interface allocated to both legs 1 and 2 correspond to each other and the connection is established, the mobile services switching centres start monitoring the traffic of the legs allocated to the connection. In the following it is exemplarily assumed that both the upgrade and the downgrade are performed for the leg 1.

At step 2-6, it is aimed at upgrading the leg 1. The decision on the need for upgrading is made according to the prior art. Differing from the prior art, in the first preferred embodiment of the invention the excess resources are preliminarily allocated to the leg 1 at step 2-6 and the message 2-7 informing about the need for upgrading is transmitted to the mobile services switching centre MSC 2. The message 2-7 includes the information on how much the amount of resources allocated to the leg 1 would be upgraded. It is expressed either directly by announcing the desired amount of additional resources or the desired total amount of the resources of the leg 1. Upon receiving it, the mobile services switching centre MSC 2 defines the information on the additional resources needed for the leg 2 and checks whether it has said amount of additional resources available at step 2-8. If there are resources available, the mobile services switching centre MSC 2 allocates them to the leg 2, updates the information on the resources allocated to the leg 2 to correspond to the new situation and transmits the acknowledgement of the upgrade in the message 2-9A. The message either includes the information on how big the upgrade was or the information on the resources allocated to the leg 2 after the upgrade. This provides the advantage that if all the desired additional resources cannot be allocated to the leg 2, the upgrade procedure can however be performed and the amount of resources in both legs is the same. Upon receiving the message 2-9A, the mobile services switching centre MSC 1 allocates the amount of additional resources to the leg 1 as expressed in the

message 2-9A and updates the information on the resources allocated to the leg 1 at step 2-10A.

In some other embodiment, in which not so much resources can be allocated to the leg 2 as it is desired, additional resources are not allocated, but it is acted as if there were no resources available.

If the mobile services switching centre MSC 2 detects at step 2-8 that no resources are available, it transmits the information forbidding the upgrade to the mobile services switching centre MSC 1 in the message 2-9B. In this case, the mobile services switching centre MSC 1 preliminarily releases the additional resources allocated to the leg 1 at step 2-10B and does not perform the upgrade procedure. This provides the advantage that such resources that cannot be used because of the smaller resources on the air interface of the second leg are not uselessly allocated on the air interface of the first leg.

In some embodiments, the mobile services switching centre MSC 2 may stay and observe its resource situation after transmitting the message 2-9B and when it detects that resources are being released, it can for its part transmit a message 2-8 requesting the upgrade procedure to the mobile services switching centre MSC 1.

At step 2-11, the leg 1 is downgraded. The decision on the need for downgrading is made according to the prior art. Differing from the prior art, in the first preferred embodiment of the invention the resource information of the leg 1 is updated at step 2-11 and the message 2-12 reporting on the downgrade is transmitted to the mobile services switching centre MSC 2. The message 2-12 includes the information on how much the amount of resources allocated to the leg 1 was downgraded. It is expressed either directly by the decreased amount of resources or by the total amount of resources of the leg 1 after the downgrade procedure. Upon receiving the message 2-12 the mobile services switching centre MSC 2 defines the information on the required reduction in resources for the leg 2, releases the useless resources and updates the information on the resources allocated to the leg 2 to correspond to the new situation. Then it transmits the acknowledgement of the downgrade in the message 2-14. The message may be a simple acknowledgement message or it can include the information either on how big the downgrade was or on the resources allocated to the leg 2 after the downgrade procedure.

In some other embodiments, the information on the resources on the air interface is not yet added to the message 2-2 but it is transmitted as a separate message after the call set-up. The information on the resources on the air interface allocated to the connection can first be transmitted from the leg 1, i.e. the mobile services switching centre MSC 1, to the leg 2, i.e. the mobile services switching centre MSC 2, which compares the resources with each other. If the resources of the leg 2 are bigger than those of the leg 1, the mobile services switching centre MSC 2 releases resources allocated to the leg 2 to correspond to the resources of the leg 1. If the resources of the leg 1 are bigger than those of the leg 2, the mobile services switching centre MSC 2 preferably transmits the information on the resources allocated to the leg 2 to the mobile services switching centre MSC 1, after which the mobile services switching centre MSC 1 compares the resources and releases a part of the resources allocated to the leg 1. The information on the resources allocated to the leg is updated. It is also possible that the mobile services switching centres transmit the information on the resources allocated to their own leg on the air interface to each other. Then, the mobile services switching centre in which more resources may have been allocated, releases the excess resources.

In some other embodiment of the invention, mobile services switching centres may transmit the information to the other mobile services switching centre always when the utilization ratio of the allocated resources changes. Then the other mobile services switching centre can conclude whether it is worthwhile to upgrade or downgrade its own leg, and if it is, with what amount it is to be done.

The steps and signalling messages described above in Figure 2 are not in an absolute chronological order and part of the steps can be performed simultaneously or as differing from the described order. The signalling messages are only illustrative and may also include several separate messages to convey the same information. Further, messages may also include other information. Messages can also be freely combined or divided into several parts. For example, the upgrade procedure may be performed by asking a permission, getting the permission, allocating additional resources, transmitting the information on the allocation of the additional resources, allocating the additional resources to the other leg and transmitting the information on that. It is essential in the first preferred embodiment that the information on the allocation situation of different legs is exchanged always when the allocation situa-

tion changes. Without this information, the allocation situation of one leg cannot be adapted to correspond to the resources allocated to the other leg. Each mobile services switching centre concludes independently, how to adapt its own situation on the basis of the resource situation of the other. Depending on the network structure, other network elements to which various functionalities have been distributed can also participate in signalling and conveying the information.

It is obvious for a person skilled in the art how the above described method is applied to a data call with several participating mobile stations.

Although it is assumed above for the sake of clarity that the channels on the air interface are allocated symmetrically, the invention can also be applied when using asymmetrical channel allocation. For example, the steps described above in Figure 2 can be carried out separately for an uplink transmission path and a downlink transmission path. Alternatively, the information on the resource situation of both directions of the leg or the need for changing the situation can always be included in messages. Then it has to be remembered that the uplink transmission path of the leg 1 has to be adapted to the downlink transmission path of the leg 2. Correspondingly, the downlink transmission path of the leg 1 has to be adapted to the uplink transmission path of the leg 2.

Figures 3 and 4 show the operation according to the second preferred embodiment of the invention. In the second preferred embodiment of the invention, separate signalling is not needed, but the interworking unit observes data traffic to the uplink and downlink directions in each connection. The connection is divided into two connection parts. The first connection part exists between the mobile station and the interworking unit. The second connection part exists between the interworking unit and the other party of the data connection. The other party can be a mobile station or a terminal in a fixed network. The difference in the transmission rate between these connection parts can be detected by observing. In the second preferred embodiment of the invention, the invention is also applicable to a call between apparatuses in two different systems, e.g. between a mobile station and a fixed network. Figure 3 illustrates the observation and adaptation of the resources on the downlink traffic channel. Correspondingly, Figure 4 illustrates the observation and adaptation of the resources on the uplink traffic channel. In the examples of Figures 3 and 4, the adaptation of the capacity on the air interface is based

on the detection of padding and/or flow control during monitoring. Alternatively, e.g. the amount of padding and the filling degree of the buffer can be monitored. Monitoring helps to detect the difference in the data transmission rates of the connection parts, and thus of the whole connection. The appearance of padding or flow control in the payload flow or the buffering of the payload flow are events indicating differences in the capacity of the connection. A difference in the capacity refers both to a difference in the use of the capacity, i.e. different transmission rates of payload, and to a difference between the amounts of various capacities. By defining the "extent" of the event, the difference between the connection parts can be concluded. The extent of padding is defined by measuring its amount, the extent of flow control is defined by its duration and the extent of buffering is defined by the filling degree of the buffer or the filling rate of the buffer.

Figure 3 starts with the situation after the call set-up. At step 301, the downlink direction of the connection is monitored. In other words, the output and input channels of the downlink direction are monitored in the interworking unit. At step 302 it is checked whether padding (fill frames, Receiver Ready frames etc.) is transmitted in the outgoing direction, i.e. in the direction of the mobile station. The transmission of padding may indicate that too much capacity on the air interface is allocated. If it is detected at step 302 that padding is going to the output channel, the amount of padding transmitted in the direction of the mobile station is measured at step 303. At step 304 the amount of the padding to be transmitted is compared with the subchannel capacity. In other words, it is checked how much padding is to be transmitted in regard to the subchannel capacity. It is thus detected how much padding there is in the transmission compared to the smallest stage of change in the capacity. The smallest stage of change is preferably the capacity of one subchannel. The stage of change can also be defined as being of a different size. On the basis of the comparison at step 304 it is detected whether in addition to the payload, the padding has to be transmitted so much that the channel capacity could be decreased without slowing down or significantly slowing down the payload transmission.

If too much capacity, i.e. at least the capacity of one subchannel, is allocated to the downlink direction, (and thus the condition of step 304 is fulfilled), the capacity allocated to the connection is decreased by the downgrade procedure performed at step 305. In the second preferred embodiment, one

subchannel is downgraded at a time. It would be possible to downgrade more subchannels at one time, if the amount of padding were equal to at least the combined capacity of the subchannels to be "released". After the downgrade procedure, it is returned to step 301 to monitor the downlink direction of the connection. It is returned to step 301 straight from step 304, if the amount of padding is not equal to at least the amount of the subchannel capacity.

If it is detected at step 302 that the padding need not be transmitted, i.e. the amount of data needs all allocated capacity, it is detected at step 306 whether the input channel, i.e. the trunk circuit, needs the flow control in the example of Figure 3. The need for flow control may indicate that too little capacity on the air interface is allocated. If the flow control is not needed, it is returned to step 301 to monitor the downlink direction.

If the flow control is needed, the duration of the flow control is detected at step 307. Then, the duration of the flow control is compared with the subchannel capacity at step 308. This way it is detected whether the duration of the flow control during the measurement period is so long that the additional capacity could be used for transferring payload. For example, if the flow control is active half the time, the channel capacity could be doubled.

If it is detected at step 308 that the extent of the flow control duration is not equal to the subchannel capacity (i.e. the size of the smallest stage of change), it is returned to step 301 to monitor the downlink direction of the connection.

If it is detected at step 308 that the duration of the flow control is at least equal to the subchannel capacity, it is checked at step 309, whether there are resources, i.e. a subchannel (or subchannels), available on the air interface. If there are no resources available on the air interface, it is returned to step 301 to monitor the downlink direction of the connection.

If it is detected at step 309 that there are resources available on the air interface, the upgrade procedure is performed at step 310 and the required amount of subchannels is allocated. Then it is moved to step 301 to monitor the downlink direction of the connection.

In the embodiments, in which the events indicating the difference in the capacity are the transmission of padding and the buffering of data flow, steps 306, 307 and 308 change in Figure 3. At step 306, the need for buffering is checked. If it is not needed, it is moved to step 301. If the buffering is needed, the filling degree or the filling rate of the data buffer is detected at

step 307. At step 308 it is checked, whether the filling degree or filling rate of the buffer exceeds a predetermined threshold. A threshold can e.g. correspond to one subchannel capacity. If the threshold is exceeded, it is moved to step 309, which is the same as in the example described above in greater detail.

The decision on the upgrade of the downlink direction can thus be made e.g. on the basis of the flow control duration or the filling degree or the filling rate of the buffer, and the decision on the downgrade of the downlink direction on the basis of the amount of padding to be transmitted. The difference in the capacity between the connection parts is detected on the basis of the padding, flow control or buffering. As it appears from what is said above, the downlink direction is upgraded, if there are resources available on the air interface and the predetermined upgrade-related conditions for the flow control duration or the filling degree or filling rate of the buffer are fulfilled. The conditions may vary from what is described above, and e.g. at step 308 the duration or the filling rate can be compared to the half of the subchannel capacity, for example. Correspondingly, the downgrade is performed, if the condition set for the amount of padding to be transmitted in advance is fulfilled. At steps 304 and 308 the change values may differ from each other. The condition relating particularly to step 304 is preferably a smallest possible change value of the capacity. This way it is ensured that the downgrade does not cause a need for flow control and/or buffering.

Figure 4 starts with the situation after the call set-up. At step 401, the uplink direction of the connection is monitored. In other words, the output and input channel of the uplink direction are monitored. At step 402 it is checked whether the input channel, i.e. the mobile station, needs a flow control in the example of Figure 4. The need for flow control may indicate that too much capacity on the air interface is allocated. If it is detected at step 402 that the flow control is needed, the duration of the flow control is detected at step 403. Thereafter, the flow control duration is compared with the subchannel capacity at step 404. This way it is found out whether the flow control duration during the measurement period is so long that the channel capacity could be decreased at least by the amount of the smallest stage of change without slowing down or significantly slowing down payload transmission.

If it is detected at step 404 that the duration of the flow control is not equal to the subchannel capacity (i.e. the size of the smallest stage of

change), it is returned to step 401 to monitor the uplink direction of the connection.

If it is detected at step 404 that the duration of the flow control is equal to at least the subchannel capacity, the capacity allocated to the connection is decreased by performing the downgrade procedure at step 405. In the second preferred embodiment, one subchannel is downgraded at a time. It would also be possible to downgrade more subchannels at one time, if the duration of the flow control were equal to at least the combined capacity of the subchannels to be "released". For example, if the flow control is active half the time, the channel capacity could be doubled. After the downgrade procedure, it is returned to step 401 to monitor the downlink direction of the connection.

If it is detected at step 402 that flow control is not needed, i.e. that the amount of data needs all capacity, it is checked at step 406 whether padding (fill frames, Receiver Ready frames etc.) is transmitted in the outgoing direction, i.e. the direction of the trunk circuit. The transmission of padding may indicate that too little capacity on the air interface is allocated. If the padding is not transmitted, it is returned from step 406 to step 401 to monitor the uplink direction of the connection.

If it is detected at step 406 that padding is going to the output channel, the amount of the padding transmitted to the trunk circuit is measured at step 407. At step 408, the amount of the padding to be transmitted is compared to the subchannel capacity. In other words, it is checked how much padding is to be transmitted compared to the subchannel capacity. This way it is detected how much padding compared to the smallest stage of change of the capacity the transmission includes. On the basis of the comparison at step 408 it is detected whether in addition to the payload, so much padding is transmitted that the additional channel capacity could be used for data transmission in such a manner that the resources on the air interface are not wasted.

If the condition at step 408 is not fulfilled, it is returned to step 401 to monitor the uplink direction of the connection.

If it is detected at step 408 that the duration of the flow control is equal to at least one subchannel capacity, it is checked at step 409 whether there are resources, i.e. a subchannel or subchannels, available on the air interface. If there are no resources available on the air interface, it is returned to step 401 to monitor the uplink direction of the connection.

If it is detected at step 409 that there are resources available on the air interface, the upgrade is performed at step 410 and a necessary amount of subchannels is allocated. Then it is moved to step 401 to monitor the uplink direction of the connection.

In the embodiments, in which the events indicating the difference in the capacity are the transmission of padding and the buffering of data flow, steps 402, 403 and 404 change in Figure 4. At step 402, the need for buffering is checked. If the buffering is not needed, it is moved to step 406, from which it is proceeded as described above. If the buffering is needed, the filling degree or the filling rate of the data buffer is detected at step 403. At step 404 it is checked, whether the filling degree or filling rate of the buffer exceeds a predetermined threshold. A threshold can e.g. correspond to one subchannel capacity. If the threshold is exceeded, it is moved to step 405, which is the same as in the example described above in greater detail.

The decision on the upgrade of the uplink direction can thus be made e.g. on the basis of the amount of padding to be transmitted and the decision on the downgrade of the uplink direction either on the basis of the flow control duration or the filling degree or the filling rate of the buffer. The difference in the capacity between the connection parts is detected on the basis of the padding, flow control or buffering. As it appears from what is said above, the uplink direction is downgraded, if a predetermined downgrade-related condition for the flow control duration or the filling degree or filling rate of the buffer is fulfilled. Correspondingly, the upgrade is performed, if there is capacity available on the air interface and the condition set for the amount of padding to be transmitted in advance is fulfilled. The conditions may differ from what is described above, and e.g. at step 408 the amount of padding can be compared to the half of the subchannel capacity. At steps 404 and 408 the change values may differ from each other. The condition relating particularly to step 404 is preferably the smallest possible change value of the capacity. This way it is ensured that the downgrade does not cause a need for flow control and/or buffering.

If in the second preferred embodiment a symmetrical allocation is used, it is preferable to combine the functions described in Figures 3 and 4. In such a combined embodiment, the downgrade is only performed if the observation of both the uplink and downlink sides supports the downgrade. If the downgrade allowed by the uplink side is not the same as the downgrade al-

lowed by the downlink side, a smaller downgrade procedure is performed with the smaller allowed downgrade.

In such a combined embodiment, the upgrade is performed if the observation of either side enables the upgrade and there is capacity available. The upgrade level is equal to the amount indicated by the observation.

The steps described above in Figures 3 and 4 are not in an absolute chronological order and part of the steps can be carried out simultaneously or as differing from the described order. Between the steps, other functions can be performed as well. The conditions for the upgrade and downgrade procedures may also differ from what is described above. The conditions may also vary according to the allocation situation of the data transmission resource (i.e. the air interface resource). For example, if all resources are allocated, a condition can be set for the downgrade procedure, the condition equalling e.g. half of the lowest possible change value of the capacity. If there are resources available, a stricter condition allowing the downgrade procedure may be used. It is essential that the real transmission rates of both connection parts, or the efficiency of the allocated transmission capacity, are compared to each other. When the comparison is made both in uplink and downlink directions, also when using the asymmetrical allocation, the optimal use of resources on the air interface of both directions is ensured.

If the mobile station requests more channel capacity (e.g. the UIMI/Modify function of the GSM, User Initiated Modification Indication), the network may utilize the prevailing capacity of the trunk circuit estimated on the basis of the functions of the invention and restrict the channel capacity of the mobile station to correspond to the situation of the trunk circuit.

It is obvious for a person skilled in the art that as the technology develops, the basic idea of the invention can be implemented in various ways. The invention and the embodiments thereof are thus not restricted to the examples described above, but they may vary within the scope of the claims in systems based on both a fixed network and wireless data transmission.

CLAIMS

1. A method for optimizing the use of data transmission resources between terminals in a telecommunication system and a network element in a telecommunication system, which method comprises the steps of:

(a) forming an end-to-end connection between the terminal in the telecommunication system and the other party of the connection, which connection comprises the first connection part between the terminal and the network element and the second connection part between the network element and the other party,

characterized by

(b) monitoring the connection (301, 401),

(c) detecting an event indicating the difference in the capacity between the connection parts during the monitoring (302, 306, 402, 406),

(d) defining the extent of the event (303, 307, 403, 407),

(e) checking whether the extent of the event fulfils a predetermined condition (304, 308, 404, 408), and

(f) if the condition is fulfilled, changing the capacity allocated to the first connection part from said data transmission resources in such a manner that the difference in the capacity between the connection parts decreases (305, 310, 405, 410).

2. A method as claimed in claim 1, **characterized** by performing the steps (b) to (f) separately for the uplink and the downlink direction of the connection.

3. A method as claimed in claim 1, **characterized** by

performing the steps (b) to (e) separately for the uplink and the downlink direction of the connection, and

upgrading said allocated capacity, if the extent of the event of either direction fulfils the predetermined condition.

4. A method as claimed in claim 1 or 3, **characterized** by

performing the steps (b) to (e) separately for the uplink and the downlink direction of the connection, and

downgrading said allocated capacity, if the condition relating to the downgrade is fulfilled in both directions.

5. A method as claimed in claim 4, **characterized** by downgrading by the amount of the smaller downgrade allowed, if the downgrade

allowed by the uplink side is not the same as the downgrade allowed by the downlink side.

6. A method as claimed in any one of the preceding claims, **characterized** by the event indicating the difference in the capacity being the transmission of padding, and its extent being defined by measuring the amount of the padding to be transmitted.

7. A method as claimed in any one of the preceding claims, **characterized** by the event indicating the difference in the capacity being the need for flow control, and its extent being defined by detecting the duration of the flow control.

8. A method as claimed in any one of the preceding claims 1 to 6, **characterized** by the event indicating the difference in the capacity being buffering, and its extent being defined by detecting the filling degree or filling rate of the buffer.

9. A method as claimed in any one of the preceding claims, **characterized** by the event indicating the difference in the capacity being the information received from the other connection part on its capacity, and its extent being defined on the basis of the difference in the capacity expressed by the information.

10. A method as claimed in any one of the preceding claims, **characterized** by the telecommunication system being a mobile communication system, and the data transmission resources being resources on the air interface.

11. A method for optimizing the use of resources on the air interface between a mobile station in a mobile communication system and a mobile communication network in a data call between the mobile station and the terminal, which method comprises the steps of:

forming an end-to-end connection in such a manner that said connection comprises the first leg between the mobile station and the mobile communication network and the second leg between the mobile communication network and the terminal,

characterized by

maintaining information on the capacity allocated to the first leg on the air interface (2-1, 2-10A, 2-11),

receiving the information on the capacity of the second leg (2-4, 2-9A, 2-9B, 2-14),

comparing the capacities with each other, and

if the capacities differ from each other, changing the capacity on the air interface of the first leg to correspond to the capacity of the second leg (2-5, 2-10A).

12. A method as claimed in claim 11, **characterized** by transmitting the information on the capacity change of the first leg to the second leg (2-12).

13. A method as claimed in claim 11 or 12, **characterized** by

transmitting the information on the intention to change the capacity of the first leg to the second leg (2-7),

receiving the information from the second leg whether it is capable of changing its capacity (2-9A, 2-9B), and

changing the capacity of the first leg (2-10A), if the second leg is capable of changing its capacity (2-10A).

14. A method as claimed in claim 11, 12 or 13, **characterized** by

receiving the information from the second leg on the intention to upgrade the capacity of the second leg (2-7),

checking the available capacity (2-8), and

if there is at least a predetermined minimum amount of capacity available, transmitting the information to the second leg that the capacity can be upgraded (2-9A), or

if there is not a predetermined minimum amount of capacity available, transmitting the information to the second leg that the capacity is not allowed to be upgraded (2-9B).

15. A mobile communication system comprising

the first mobile station (MS A) and the second mobile station (MS B),

a mobile communication network (GSM) to establish and maintain a connection between said mobile stations,

an air interface (Air) between the mobile stations (MS A, MS B) and the mobile communication network (GSM), and

the mobile communication network comprising the first network element (MSC 1, IWU) to form the first leg of the connection between the first mobile station (MS A) and the first network element and to allocate capacity to

the first leg from the air interface, and the second network element (MSC 2, IWU) to form the second leg between the second mobile station (MS A) and the second network element and to allocate capacity to the second leg from the air interface,

characterized in that

the first network element (MSC 1, IWU) is arranged to maintain information on the capacity allocated to the first leg from the air interface, receive information on the capacity of the second leg, compare the capacities with each other and change the capacity of the first leg to correspond to that of the second leg in response to the difference between the capacities, and

the second network element (MSC 2, IWU) is arranged to transmit information to the first network element on the capacity of the second leg.

16. A mobile communication system as claimed in claim 15, **characterized** in that the second network element (MSC 2, IWU) is arranged to transmit information on the capacity of the second leg to the first network element in response to the capacity change of the second leg.

17. A mobile communication system as claimed in claim 15 or 16, **characterized** in that the first network element (MSC 1, IWU) is arranged to inquire of the second network element (MSC 2, IWU) whether the capacity of the second leg can be changed, receive the response to the inquiry and change the capacity of the first leg only if the capacity of the second network element can be changed, and

the second network element is arranged to receive the inquiry about the possibility to change the capacity of the second leg and to transmit information to the first network element on the possibilities to change the capacity of the second leg in response to the inquiry about the possibility of change.

18. A mobile communication system as claimed in claim 15, 16 or 17, **characterized** in that the first network element and the second network element are the same network element (MSC, IWU), which is arranged to convey information on the capacity of the first and the second leg as an internal information of the network element.

19. An interworking unit (IWU) of the telecommunication network, **characterized** in that it is arranged to monitor the connection between the terminal in connection with the telecommunication network and the second party, detect the event indicating the difference in the capacity between the first connection part between the terminal and the interworking unit and the

second connection part between the second party and the interworking unit, define the extent of the event and change the capacity allocated to the connection from the data transmission resources between the telecommunication network and the terminals, if the extent of the event fulfils the predetermined condition.

20. An interworking unit (IWU) as claimed in claim 19, **characterized** in that it is arranged to monitor, detect, define and change said allocated capacity separately to the uplink and the downlink direction of the connection.

21. An interworking unit (IWU) as claimed in claim 19, **characterized** in that it is arranged to monitor, detect and define the uplink and the downlink direction of the connection separately and increase said allocated capacity if the condition relating to the upgrade of the capacity is fulfilled in either direction and decrease the capacity on the air interface only if the condition relating to the downgrade of the capacity is fulfilled in both directions.

22. An interworking unit (IWU) as claimed in claim 19, 20 or 21, **characterized** in that it is an interworking unit of the mobile communication network and the data transmission resources are resources on the air interface.

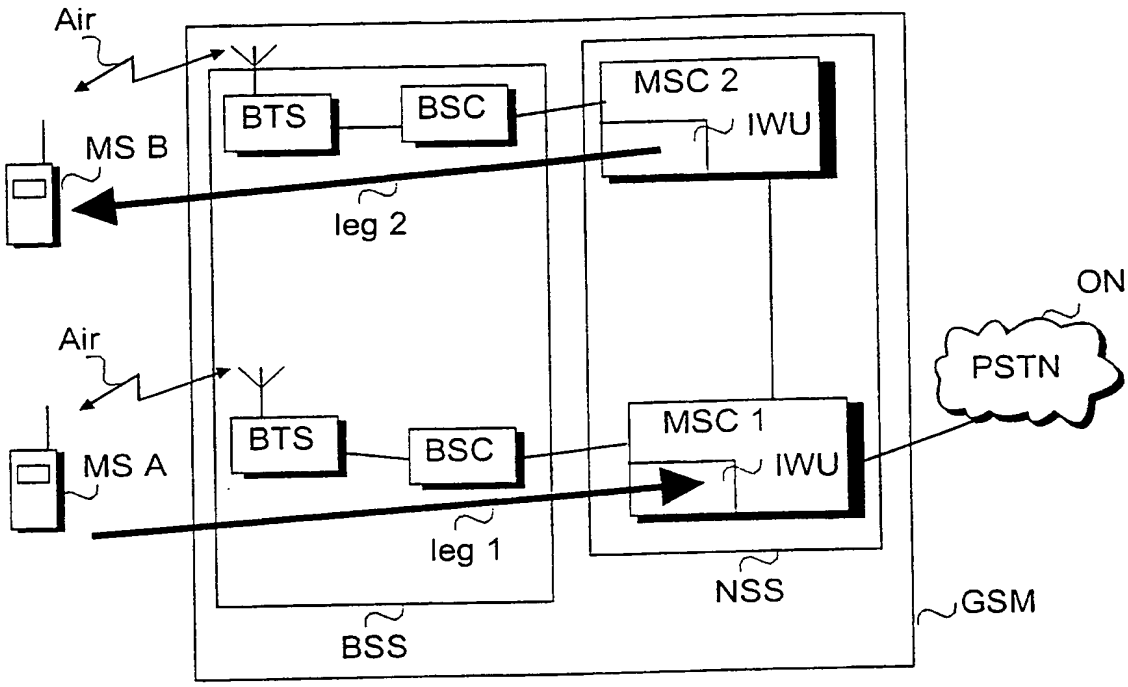
Air
MS B
BTS
BSC
MSC 2
IWU
leg 2
Air
MS A
BTS
BSC
MSC 1
IWU
leg 1
ON
PSTN
NSS
GSM
BSS

FIG.1

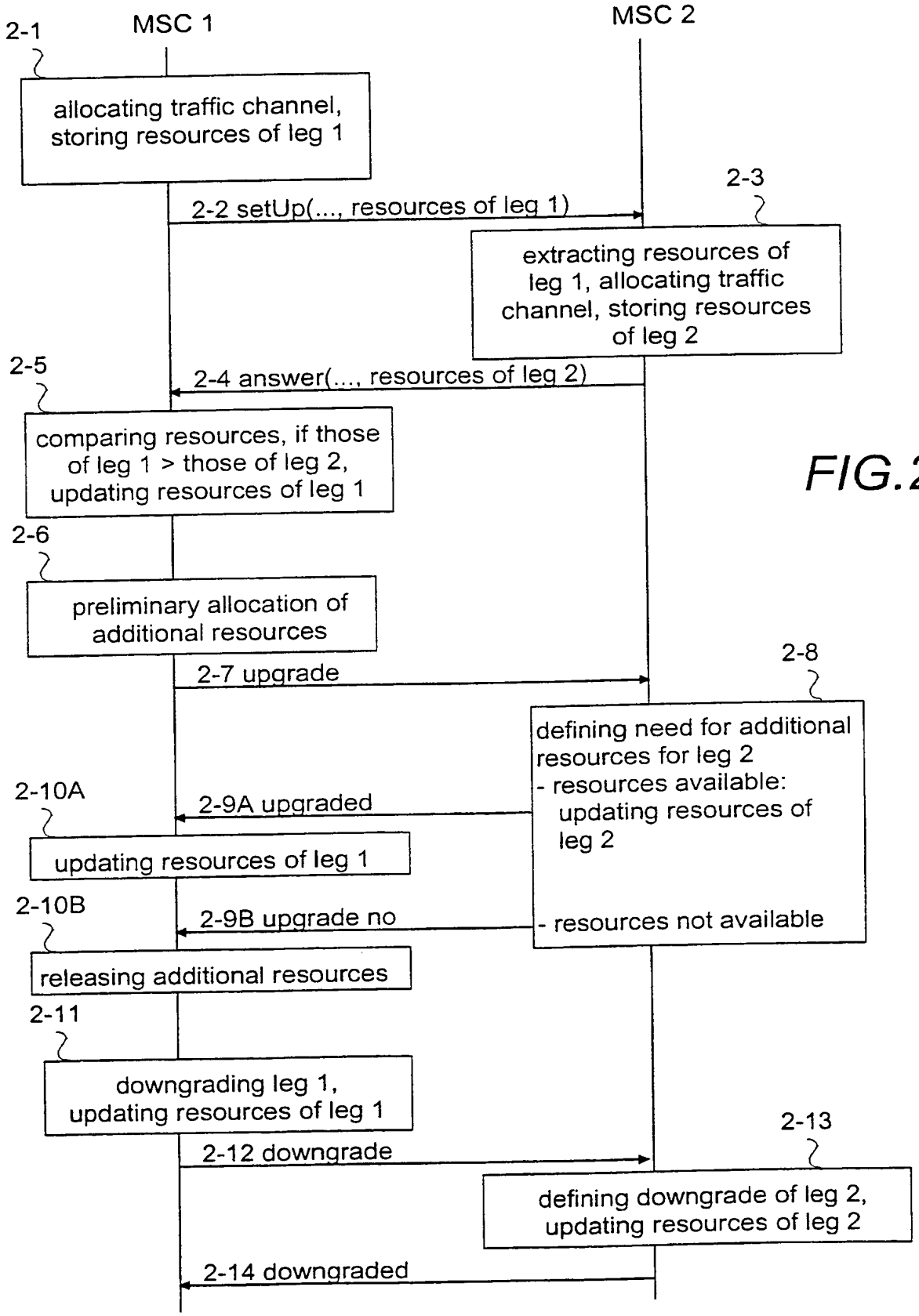
MSC 1
MSC 2
2-1
allocating traffic channel, storing resources of leg 1
2-2 setUp(..., resources of leg 1)
2-3
extracting resources of leg 1, allocating traffic channel, storing resources of leg 2
2-4 answer(..., resources of leg 2)
2-5
comparing resources, if those of leg 1 > those of leg 2, updating resources of leg 1
2-6
preliminary allocation of additional resources
2-7 upgrade
2-8
defining need for additional resources for leg 2
- resources available: updating resources of leg 2
- resources not available
2-9A upgraded
2-10A
updating resources of leg 1
2-9B upgrade no
2-10B
releasing additional resources
2-11
downgrading leg 1, updating resources of leg 1
2-12 downgrade
2-13
defining downgrade of leg 2, updating resources of leg 2
2-14 downgraded

FIG.2

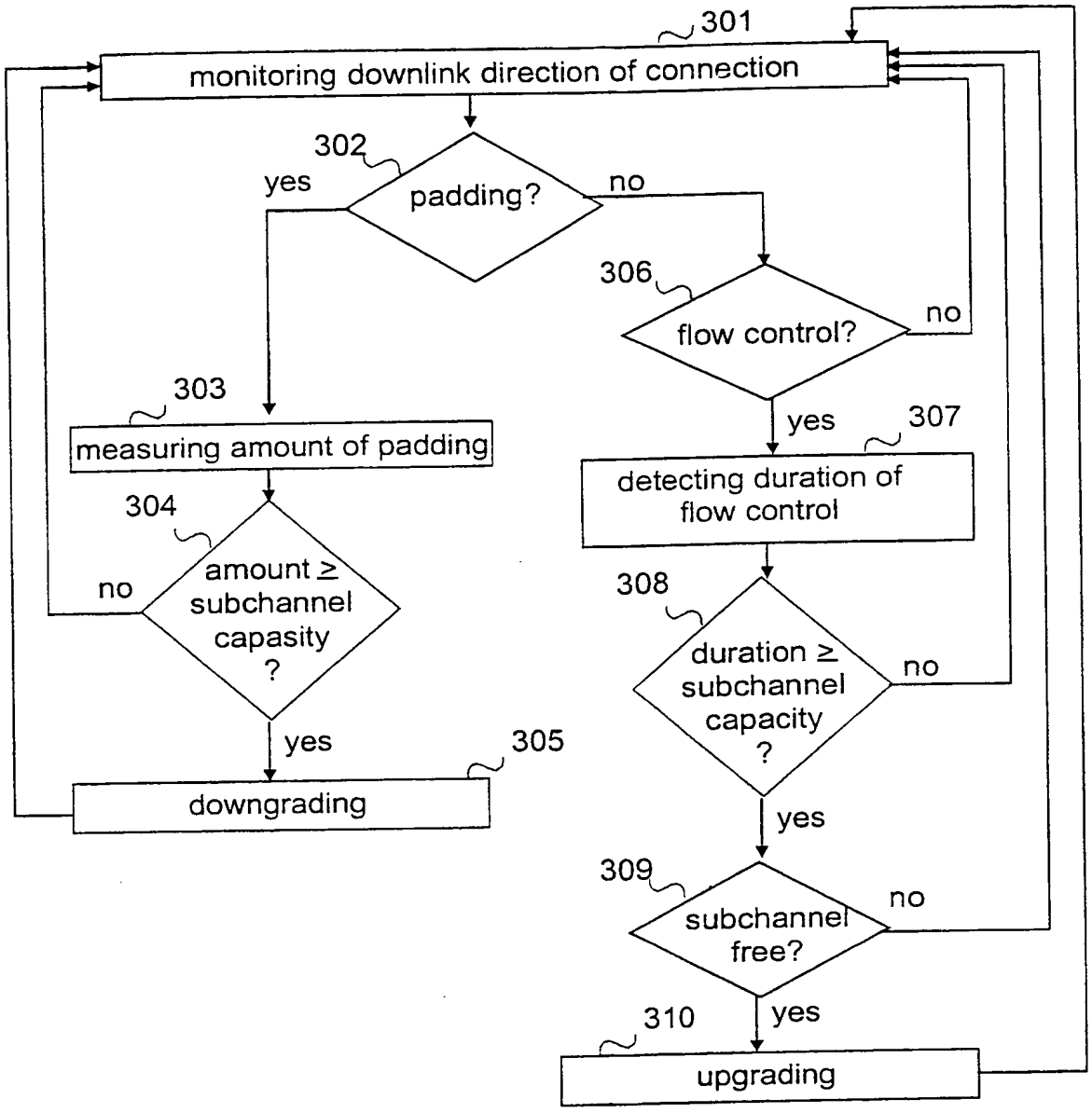
301
monitoring downlink direction of connection
302
padding?
yes
no
303
measuring amount of padding
304
amount ≥ subchannel capasity ?
no
yes
305
downgrading
306
flow control?
no
yes
307
detecting duration of flow control
308
duration ≥ subchannel capacity ?
no
yes
309
subchannel free?
no
yes
310
upgrading

FIG.3

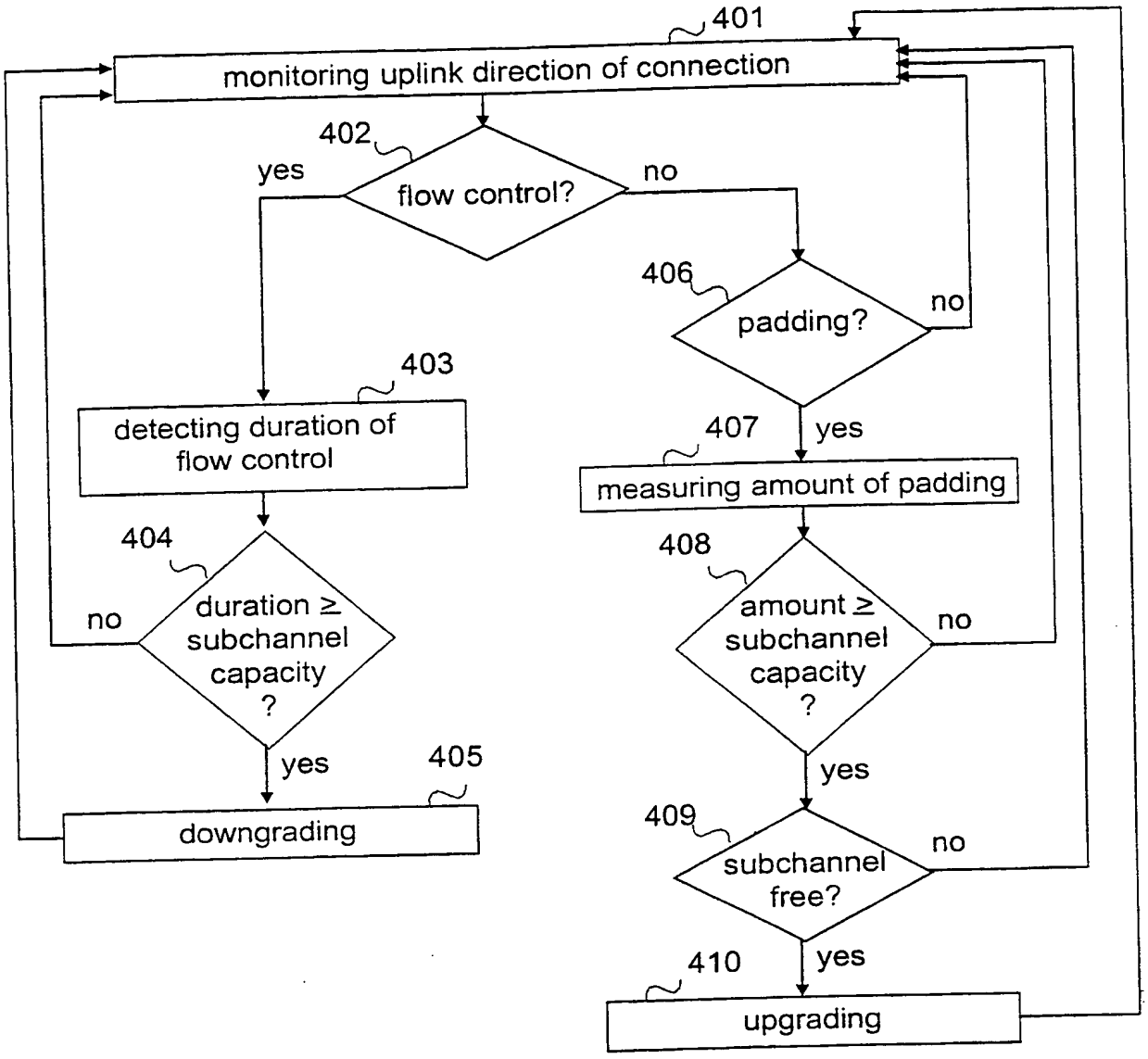
401
monitoring uplink direction of connection
402
flow control?
yes
no
406
padding?
no
403
detecting duration of flow control
407
yes
measuring amount of padding
404
duration ≥ subchannel capacity ?
no
408
amount ≥ subchannel capacity ?
no
yes
405
downgrading
yes
409
subchannel free?
no
410
yes
upgrading

FIG.4

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 99/00840

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: H04Q 7/24
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: H04Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 9723110 A1 (NOKIA TELECOMMUNICATIONS OY), 26 June 1997 (26.06.97), page 3, line 6 - page 5, line 12 --	1,11,15,19
A	WO 9610320 A2 (NOKIA TELECOMMUNICATIONS OY), 4 April 1996 (04.04.96), abstract --	1,11,15,19

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" erlier document but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
17 March 2000	22 -03- 2000
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Jaana Raivio/cs Telephone No. +46 8 782 25 00

INTERNATIONAL SEARCH REPORT

Information on patent family members

02/12/99

International application No.
PCT/FI 99/00840

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9723110 A1	26/06/97	AU 1099397 A	14/07/97
		EP 0868826 A	07/10/98
		FI 101924 B	00/00/00
		FI 956089 A	19/06/97
WO 9610320 A2	04/04/96	AU 701594 B	04/02/99
		AU 3523995 A	19/04/96
		CA 2200308 A	04/04/96
		EP 0783826 A	16/07/97
		FI 96557 B,C	29/03/96
		FI 944487 D	00/00/00
		FI 971269 A	26/03/97
		JP 10511818 T	10/11/98

PATENTTI- JA REKISTERIHALLITUS

HYVÄKSYVÄ VÄLIPÄÄTÖS
PA 29 a §:n mukaan

28.09.99

Kolster Oy Ab

Iso Roobertinkatu 23

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Patenttihakemus nro:	982222
Luokka:	H 04Q / JSA / PO
Hakija:	Nokia Telecommunications Oy
Asiamies:	Kolster Oy Ab
Asiamiehen viite:	2980538FI
Määräpäivä	28.03.2000

Patenttihakemuksen numero ja luokka on mainittava kirjelmässänne PRH:lle

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Patenttivaatimuksissa määritellyt keksinnöt ovat suoritetun tutkimuksen perusteella patentoitavissa (patenttilaki 1 ja 2 §).

Yleistä tekniikan tasoa edustavina esitetään seuraavat julkaisut:

1. WO 96/10320, Nokia Telecommunications Oy, 4.4.1996, H04J 3/16
2. US 5,684,791, NEC USA Inc., 4.11.1997, H04B 7/212

Viitejulkaisussa 1 esitetään aikajakoista tiedonsiirtoa matkaviestinjärjestelmässä ja viitejulkaisussa 2 langatonta asynkronista tiedonsiirtomuotoa. Asynkronisessa tiedonsiirtomuodossa toteutetut vapaana oleva ABR, vakio CBR ja muuttuva VBR tiedonsiirtonopeus voivat sisältää vastaavantyyppisen toteutuksen ATM-tekniikalla TDMA/TDD-kehysrakenteessa kuin hakemuksessa on esitetty, mutta tämän ei katsota olevan hakemuksessa esitetyn keksinnön patentoinnin este.

Oheisena lähetetään asiakirjat, jotka osoittavat, missä muodossa virasto aikoo myöntää patentin. Teidän tulee määräajan kuluessa antaa lausumanne siitä, hyväksyttekö Te tämän muodon. Viraston lähettämät asiakirjat tulee palauttaa.

Asiakirjoissa olevat lyijykynämerkityt kohdat pyydetään korjaamaan sekä toimittamaan patenttivaatimukset ja tiivistelmä ruotsin kielellä.

PATENTTI- JA REKISTERIHALLITUS

Petri Ojamies

Tutkijainsinööri
Puhelin: (09) 69395708

Petri Ojamies

Liitteet: viitejulkaisukopiot 1 kpl:na, tutkimusraportti ja hakemusteksti

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Katuosoite: Arkadiankatu 6 A, 00100 Helsinki
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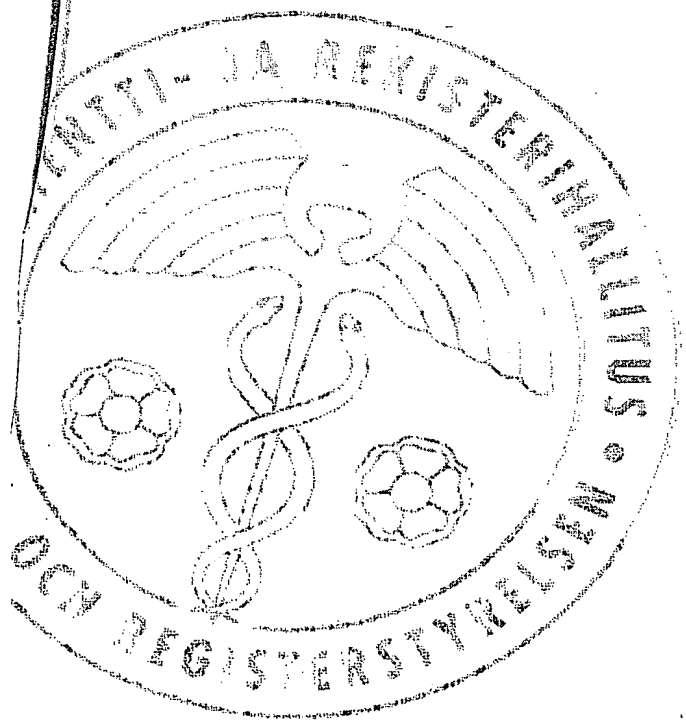
Lausumanne on annettava viimeistään yllämainittuna määräpäivänä. Jollette ole antanut lausumaanne virastoon viimeistään mainittuna määräpäivänä tai ryhtynyt toimenpiteisiin tässä välipäätöksessä esitettyjen puutteellisuuksien korjaamiseksi, jätetään hakemus sillensä (patenttilain 15 §). Sillensä jätetty hakemus otetaan uudelleen käsiteltäväksi, jos Te neljän kuukauden kuluessa määräpäivästä annatte lausumanne tai ryhdytte toimenpiteisiin esitettyjen puutteellisuuksien korjaamiseksi ja samassa ajassa suoritatte vahvistetun maksun, 320 mk hakemuksen ottamisesta uudelleen käsiteltäväksi. Jos lausumanne on annettu virastoon oikeassa ajassa, mutta esitettyjä puutteellisuuksia ei ole siten korjattu, että hakemus voitaisiin hyväksyä, se hylätään, mikäli virastolla ei ole aihetta antaa Teille uutta välipäätöstä (patenttilain 16 §). Uusi keksinnön selitys, siihen tehdyt lisäykset ja uudet patenttivaatimukset on aina jätettävä kahtena kappaleena ja tällöin on otettava huomioon patenttiasetuksen 19 §.



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Pankki: Leonia
800015-47908

PATENTTI- JA REKISTERIHALLITUS
Patentti- ja innovaatiolinja

TUTKIMUSRAPORTTI

PATENTTIHAKEMUS NRO	LUOKITUS
982222	H04Q 7/20, H04L 5/00

TUTKITTU AINEISTO

Patenttijulkaisukokoelma (FI, SE, NO, DK, DE, CH, EP, WO, GB, US), tutkitut luokat

H04Q 7/20 (FI), H04L 5/00 (FI)

Tiedonhaut ja muu aineisto

Epoque: Epodoc

VIITEJULKAISUT

Kategoria*)	Julkaisun tunnistetiedot	Koskee vaatimuksia
A	WO 96/10320 Nokia Telecommunications Oy, 4.4.1996, H04J 3/16	
A	US 5,684,791 NEC USA Inc., 4.11.1997, H04B 7/212	

*) X Patentoitavuuden kannalta merkittävä julkaisu yksinään tarkasteltuna
Y Patentoitavuuden kannalta merkittävä julkaisu, kun otetaan huomioon tämä ja yksi tai useampi samaan kategoriaan kuuluva julkaisu
A Yleistä tekniikan tasoa edustava julkaisu, ei kuitenkaan patentoitavuuden este

Päiväys	Tutkija
27.9.1999	Petri Ojamies

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference 2980538PC/su	**FOR FURTHER ACTION**	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
International application No. PCT/FI99/00840	International filing date *(day month year)* 11.10.1999	Priority date *(day month year)* 13.10.1998
International Patent Classification (IPC) or national classification and IPC7 H04Q 7/24		
Applicant Nokia Networks OY et al		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 3 sheets, including this cover sheet.

   ☐ This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of _____ sheets.

3. This report contains indications relating to the following items:

   I ☒ Basis of the report

   II ☐ Priority

   III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability

   IV ☐ Lack of unity of invention

   V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

   VI ☐ Certain documents cited

   VII ☐ Certain defects in the international application

   VIII ☐ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
26.04.2000	21.09.2000
Name and mailing address of the IPEA/SE Patent- och registreringsverket Box 5055 S-102 42 STOCKHOLM Facsimile No. 08-667 72 88	Authorized officer Jaana Raivio/js Telephone No. 08-782 25 00

Form PCT/IPEA/409 (cover sheet) (January 1994)

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.
PCT/FI99/00840

I. Basis of the report

1. This report has been drawn on the basis of *(Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to the report since they do not contain amendments.)*:

☒ the international application as originally filed.

☐ the description, pages _____, as originally filed,
pages _____, filed with the demand,
pages _____, filed with the letter of _____.
pages _____, filed with the letter of _____.

☐ the claims, Nos. _____, as originally filed,
Nos. _____, as amended under Article 19,
Nos. _____, filed with the demand,
Nos. _____, filed with the letter of _____.
Nos. _____, filed with the letter of _____.

☐ the drawings, ~~sheets~~/fig _____, as originally filed,
~~sheets~~/fig _____, filed with the demand
~~sheets~~/fig _____, filed with the letter of _____.
~~sheets~~/fig _____, filed with the letter of _____.

2. The amendments have resulted in the cancellation of:

☐ the description, pages _____
☐ the claims, Nos. _____
☐ the drawings, ~~sheets~~/fig _____

3. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the supplemental Box (Rule 70.2(c)).

4. Additional observations, if necessary:

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.
PCT/FI99/00840

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims	1-22	YES
	Claims		NO
Inventive step (IS)	Claims	1-22	YES
	Claims		NO
Industrial applicability (IA)	Claims	1-22	YES
	Claims		NO

2. Citations and explanations

The claimed invention relates to a method for optimising the use of data transmission resources in a telecommunications system. In an end-to-end connection between for example two mobile stations, the different connection parts are observed and compared (first mobile station to a base station being one connection part for example). If the transmission capacity of different connection parts differs, the allocated capacity is changed so as to decrease this difference.

Documents cited in the International Search Report:
D1: WO 97 23110
D2: WO 96 10320

D1 relates to an inter-MSC handover. The first mobile switching centre (MSC) indicates to the second MSC at least the minimum number of channels required over the connection.

D2 relates to a data transmission method in a mobile communications system. A mobile station indicates the minimum and maximum requirements for the data transfer rate.

Documents D1-D2 are considered to constitute the state of the art. None of D1-D2 show a method for monitoring the capacity of different connection parts of a connection and comparing and adjusting differences. The invention as claimed in claims 1-22 is, with reference to D1-D2, novel and considered to involve an inventive step. The invention as claimed in claims 1-22 is considered to have industrial applicability.